

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
26 May 2005 (26.05.2005)

PCT

(10) International Publication Number
WO 2005/048352 A1

(51) International Patent Classification⁷: **H01L 29/739**,
29/78, 29/423

(21) International Application Number:
PCT/JP2004/016792

(22) International Filing Date:
5 November 2004 (05.11.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2003-382834 12 November 2003 (12.11.2003) JP

(71) Applicant (for all designated States except US): **TOYOTA JIDOSHA KABUSHIKI KAISHA [JP/JP]**; 1, Toyota-cho, Toyota-shi, Aichi 471-8571 (JP).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **HOTTA, Koji [JP/JP]**; c/o Toyota Jidosha Kabushiki Kaisha, 1, Toyota-cho, Toyota-shi, Aichi 471-8571 (JP). **KAWAJI, Sachiko [JP/JP]**; c/o Kabushiki Kaisha Toyota Chuo Kenkyusho, 41-1, Aza Yokomichi, Oaza Nagakute, Nagakute-cho, Aichi-gun, Aichi 480-1192 (JP). **USUI,**

Masanori [JP/JP]; c/o Kabushiki Kaisha Toyota Chuo Kenkyusho, 41-1, Aza Yokomichi, Oaza Nagakute, Nagakute-cho, Aichi-gun, Aichi 480-1192 (JP). **SUGIYAMA, Takahide [JP/JP]**; c/o Kabushiki Kaisha Toyota Chuo Kenkyusho, 41-1, Aza Yokomichi, Oaza Nagakute, Oaza Nagakute, Nagakute-cho, Aichi-gun, Aichi 480-1192 (JP).

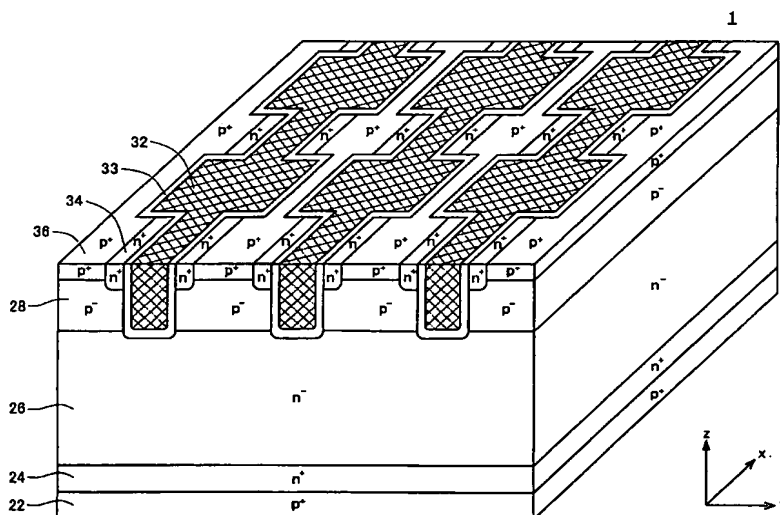
(74) Agent: **TOKKYO GYOMU HOUJIN KAIYU KOKUSAI TOKKYO JIMUSHO**; Nisseki Meieki Building 7F, 45-14, Meieki 2-chome, Nakamura-ku, Nagoya-shi, Aichi 450-0002 (JP).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH,

[Continued on next page]

(54) Title: TRENCH GATE FIELD EFFECT DEVICES



(57) Abstract: The present invention provides a technique for accumulating minority carriers in the body region, that is, the intermediate region interposed between the top region and the deep region, and thus increasing the concentration of minority carriers in the intermediate region. A semiconductor device has a top region (34) of a second conductivity type, a deep region (26) of the second conductivity type, and an intermediate region (28) of a first conductivity type for isolating the top region and the deep region. The semiconductor device further has a trench gate (32) facing a portion of the intermediate region via an insulating layer (33). The portion facing the trench gate isolates the top region and the deep region. The trench gate extends along a longitudinal direction. The width of the trench gate is not uniform along the longitudinal direction; instead the width of the trench gate varies along the longitudinal direction.



GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.